

Pulmonary Epithelial Integrity in Children - Relationship to Ambient Ozone Exposure and Swimming Pool Attendance

**Birgitta Json Lagerkvist, Alfred Bernard, Anders Blomberg,
Erik Bergstrom, Bertil Forsberg, Karin Holmstrom,
Kjell Karp, Nils-Goran Lundstrom, Bo Segerstedt,
Mona Svensson, and Gunnar Nordberg**

doi:10.1289/ehp.7027 (available at <http://dx.doi.org/>)

Online 13 September 2004



**Pulmonary Epithelial Integrity in Children -
Relationship to Ambient Ozone Exposure and Swimming Pool Attendance.**

Birgitta Json Lagerkvist¹, Alfred Bernard⁵, Anders Blomberg², Erik Bergstrom³, Bertil Forsberg¹, Karin Holmstrom⁴, Kjell Karp⁴, Nils-Goran Lundstrom¹, Bo Segerstedt¹, Mona Svensson¹, and Gunnar Nordberg¹.

¹Environmental & Occupational Med., ²Respiratory Med. & Allergy, Dep. of Public Health and Clinical Medicine, ³Paediatrics, Dep. of Clinical Sciences, and ⁴Clinical Physiology, Dep. of Surgical and Peri-operative sciences, Umea University Umea, Sweden. ⁵Unit of Ind. Toxicology, Catholic Univ. of Louvain, Brussels, Belgium.

The study was performed at Environmental Medicine, Department of Public Health and Clinical Medicine, Umea University, Umea, Sweden.

Address correspondence to B Json Lagerkvist, Environmental Medicine, Department of Public Health and Clinical Medicine, Umea University, S-901 87 Umea, Sweden.

Telephone +46 90-7851343. Fax: +46 90-779630. E-mail:

Birgitta.Lagerkvist@envmed.umu.se

Key words: Clara cell protein-CC16, airway irritants, ozone, nitrogen trichloride, swimming pool, children

Acknowledgement: Financial support has been given by the European Commission (HELIOS project, QLK4-1308), the Swedish EPA, and FORMAS. The research nurse Margarethe Backman, Paediatrics, has contributed with excellent work in the practical part of this study. Annika Hagenbjork-Gustafsson, the National Institute for Working Life, Umea, performed the ozone measurements. A conflict of interest was not reported for anyone.

Abbreviations used:

BMI, Body mass index, kg/m^2

EPA, Environmental Protection Agency

FORMAS, Forskningsradet for Miljo, Areella Naringar och Samhalle

O₃, ozone

O₂, oxygen

NO₂, nitrogen dioxide

NCl₃, nitrogen trichloride, trichloramine or chlorine azide

FVC, forced vital capacity, litre

FEV₁, forced expiratory volume in one second, litre/s

FEV₁% predicted, percent of the predicted normal value of FEV₁ calculated from age, sex, height, and weight of the subject

Section headings

Abstract

Introduction

Subjects and Methods

Results

Discussion

Conclusions

References

Tables

Figure legend

Figure

Abstract

Airway irritants such as ozone (O₃) are known to impair lung function and induce airway inflammation. Clara cell protein (CC16) is a small anti-inflammatory protein secreted by the non-ciliated bronchiolar Clara cells. CC16 in serum has been proposed as a non-invasive and sensitive marker of lung epithelial injury. In this study, we used lung function and serum CC16 concentration to examine the pulmonary responses to ambient ozone exposure and swimming pool attendance. The measurements were made on 57 children 10-11 years old before and after outdoor exercise for two hours. Individual ozone exposure was estimated as the total exposure dose between 7 AM until the second blood sample was obtained, (mean O₃ concentration/m³ x hours). The maximal one-hour value was 118 µg/m³ (59 ppb), and the individual exposure dose ranged between 352-914 µg/m³h. These ozone levels did not cause any significant changes in mean serum CC16 concentrations before or after outdoor exercise. Nor was any decrease in lung function detected. However, children who regularly visited chlorinated indoor swimming pools had significantly lower CC16 levels in serum than non-swimming children both before and after exercise, 5.7±2.4 and 5.3±1.7 µg/l versus 8.2±2.8 and 8.0±2.6 µg/l, p<0.002. These results indicate that repeated exposure to chlorination by-products in the air of indoor swimming pools have adverse effects on the Clara cell function in children. A possible relation between such damage to Clara cells and pulmonary morbidity (e.g. asthma) should be further investigated.